

MACHINE TRANSLATION OF JAPANESE PATENT NO 2002-04596A

[Obtained from Japanese Patent Office Website]

Claim(s)]

[Claim 1] The casting approach of the amorphous alloy characterized by cooling said mold below to the crystallization temperature of said amorphous alloy, and casting a dissolution metal in the casting approach which casts the dissolution metal of the presentation which has amorphous organization potency to the mold manufactured by the lost wax process, and makes it an amorphous alloy.

[Claim 2] The casting approach of the amorphous alloy according to claim 1 which carries out heating maintenance and casts a dissolution metal to with a melting point melting point [of an amorphous alloy / melting point +200 degrees C or less of -100 degrees C or more] temperature.

[Claim 3] The casting approach of the amorphous alloy according to claim 1 or 2 which casts the dissolution metal which consists of $50 \leq \text{Pt} \leq 75\%$, $5 \leq \text{Cu} \leq 50\%$, and $15 \leq \text{P} \leq 25\%$ (all are atomic %) as a presentation which has amorphous organization potency.

[Claim 4] The casting approach of the amorphous alloy according to claim 1 or 2 which casts the dissolution metal which consists of $5 \leq \text{Pt} \leq 75\%$, $0 \leq \text{Pd} \leq 50\%$, $5 \leq \text{Cu} \leq 50\%$, and $15 \leq \text{P} \leq 25\%$ (all are atomic %) as a presentation which has amorphous organization potency.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the casting approach of an amorphous alloy. It is related with the casting approach for casting in detail the dissolution metal of the presentation which has amorphous organization potency, and making the solidification structure amorphous, and manufacturing the product of a complicated configuration.

[0002]

[Description of the Prior Art] An amorphous alloy being an ingredient which has the atomic arrangement which does not have the order nature of the super-range unlike the crystalline structure which a common metallic material has although called a supercooling metal or a glass metal, originating in this structure, and having unique physical and chemical property is known.

[0003] Although this amorphous alloy is manufactured by the super-rapid solidification from a

liquid condition, sufficient cooling rate to prevent generation and growth of a crystalline nucleus is required for the cooling rate in this case (for example, in a precious alloy, it is 102-104 degrees C/sec, and the cooling rate of 105-106 degrees C / sec extent is required of that of other alloy systems). And although a process like the approach (a single roll, the congruence rolling method) of dropping molten metal on the water-cooled roll which carries out high-speed rotation as rapid solidification which realizes such a cooling rate, for example is known, there is a limitation in the magnitude of the amorphous alloy manufactured by such rapid solidification, and only the ingredient of the shape of a needle, powder, and a flake can be manufactured on a foil.

[0004] However, about the alloy which becomes recent years and has a predetermined presentation, also with the comparatively low cooling rate later than the above-mentioned cooling rate, amorphous-izing of an ingredient organization is possible and things became clear. Consequently, it is possible to also enable ** not to be based on the rapid solidification which has a limitation in the above-mentioned product dimension, but to manufacture an amorphous alloy, and to obtain a massive amorphous alloy with general casting. Thereby, the application of an amorphous alloy is spreading and the application to the accessories of an amorphous alloy and dental materials is considered taking advantage of the property of the high degree of hardness.

[0005] By the way, since it has a configuration complicated [accessories and dental materials] and detailed, generally in the case of its manufacture and shaping, precision casting and its lost wax process whose number is one are applied especially. A lost wax process is the approach of manufacturing the mold of a precision configuration and casting using this precision mold by making a model from wax material, such as paraffin, heating mold for the molding material of the shape of powder or a slurry on this model, after carrying out a laminating, spreading and, and carrying out dissolution removal of the wax material. According to this lost wax process, there is an advantage that it is low cost simply and the thing of a detailed and complicated configuration can be manufactured in large quantities.

[0006] On the other hand, making it spread a dissolution metal how in mold and casting defects, such as ** and a crack, not arise in the mold goods after coagulation is mentioned as a point that it must mind by the casting by the lost wax process. And to secure the fluidity of a dissolution metal by cooling a dissolution metal slowly inside mold as a means for it is confirmed. After calcinating mold for reservation on the strength, mold temperature is held to an elevated temperature (about 700 degrees C), and he installs this mold in a casting machine, and is trying

to specifically cast a dissolution metal. That is, without considering as an elevated temperature so much, the temperature of a molten metal is holding the temperature of mold to an elevated temperature, and has secured the fluidity of the dissolution metal in mold. It is because it is based on the idea that the temperature of the dissolution metal at the time of cast needs to make into an elevated temperature a part to make it as low as possible, and mold temperature since the gas by which occlusion was carried out into the raw material is emitted at the time of coagulation and making a dissolution metal into an elevated temperature causes casting defect generating as a reason of doing in this way.

[0007] However, about an amorphous alloy, although the configuration after coagulation (flattery nature to a mold configuration) is satisfactory when it casts in the general idea in this lost wax process, that organization cannot be completely made amorphous but a part or most may crystallize. And as a result, the product which does not possess a desired property will be manufactured.

[0008]

[Problem(s) to be Solved by the Invention] In case this invention is made under the above backgrounds, casts the alloy which has amorphous organization potency and manufactures an amorphous alloy, it aims at offering the casting approach which reproduces the detailed configuration of mold faithfully and a casting defect does not generate while it makes the organization amorphous.

[0009]

[Means for Solving the Problem] As mentioned above, formation of an amorphous organization is accomplished by quenching from a melting condition. And however this may be an alloy system in which amorphous-izing is possible in a comparatively low cooling rate, it is the same, and amorphous-ization is not produced if it does not quench to some extent. With the above-mentioned conventional casting, since mold temperature is made into the elevated temperature, it does not quench molten metal, but even if it is the presentation which has amorphous organization potency, it is thought that crystallization advances. It found out that this invention persons repeat examination about the description of the amorphous alloy of a melting condition, consequently the amorphous alloy of a melting condition had a very good fluidity, it quenched it especially, and a liquid condition could be held also at the temperature below the congealing point in the condition of a supercooled liquid. And an amorphous alloy with this good fluidity is

considered that the fluidity of molten metal is securable even if it does not hold mold to an elevated temperature. Then, about an amorphous alloy, this invention persons also took quenching molten metal into consideration, and attaining amorphous-ization by making mold temperature into low temperature contrary to the technique in the conventional lost wax process, they came to hit on an idea of this invention noting that they could reproduce the detailed configuration of mold faithfully.

[0010] That is, invention of this application claim 1 publication is the casting approach of the amorphous alloy characterized by cooling said mold below to the crystallization temperature of said amorphous alloy, and casting a dissolution metal in the casting approach which casts the dissolution metal of the presentation which has amorphous organization potency to the mold manufactured by the lost wax process, and makes it an amorphous alloy.

[0011] Here, as it is in the publication of claim 1, cooling temperature of mold is made below into the crystallization temperature of the amorphous alloy for the purpose of manufacture. When crystallization temperature heats a solid amorphous alloy, it means the temperature which crystallization starts. This crystallization temperature can manufacture the amorphous alloy for the purpose of casting, and the amorphous alloy of the same presentation at a process other than the casting by this invention (in this case, it does not interfere with the super-quenching method or metal mold casting in the above-mentioned conventional technique.), and can specify them by measuring by the differential calorimetric analysis method about this amorphous alloy. And the organization after coagulation can be completely made amorphous by making mold temperature below into crystallization temperature in this way. Although it is desirable to make it low temperature as much as possible if this cooling temperature is below crystallization temperature, generally it is enough made amorphous also at a room temperature.

[0012] Moreover, although selected as the cooling approach of this mold by the mold temperature determined from the amount of molten metal, and the crystallization temperature of that metal When casting a thick large-sized product, even after carrying out water cooling of the mold circumference compulsorily or casting a dissolution metal by laying a metal with high thermal conductivity underground in mold, the temperature of mold can be reduced and it can be made amorphous to the interior also about a thick product. Moreover, since mold size also ends small about a small closing-in product, extent kept and cooled with a freezer by the cast activity is also enough.

[0013] In addition, the mold used in the publication of claim 1 is limited to ROSUTO wax mold for clarifying the difference with the conventional technique about a technique for this invention applying ROSUTO wax casting about an amorphous alloy. That is, although the product of an amorphous organization was able to be manufactured even if cast without knowing from the former what applied permanent molds (metal mold), such as copper, also about the amorphous alloy, and being conscious of especially mold temperature in this case, the product configuration manufactured by metal mold could not but become the thing of a simple configuration. This invention indicates the technique which makes solidification structure amorphous based on an idea with the completely reverse common sense in the conventional lost wax process, and specifies this point while it means manufacturing the product of a complicated configuration, therefore applies a lost wax process.

[0014] Here, as the quality of the material of ROSUTO wax mold, especially if manufacture with a lost wax process is possible, it will not be limited. That is, there should just be no deformation even in the bottom whenever [in the dewaxing process after covering a wax model / stoving temperature]. Although that to which the laminating of the refractories very fine particle was generally carried out with the binder is used in the lost wax process, gypsum fibrosum ($\text{CaSO}_4 \cdot 1/2\text{H}_2\text{O}$) may be used. Especially a plaster mold has a smooth front face, and since dimensional accuracy is high, it is suitable for shaping of the amorphous alloy of a complicated configuration.

[0015] Moreover, in order to prevent an amorphous alloy's securing the fluidity of molten metal, and solidifying it as molten metal is mold although its fluidity is good at the time of melting and it spreads in mold promptly also at low temperature comparatively at it, it is [like] desirable according to claim 2 to carry out heating maintenance and to cast a dissolution metal to with a melting point melting point [of an amorphous alloy / melting point +200 degrees C or less of -100 degrees C or more] temperature. It is because it does not quench having made the upper limit of whenever [this stoving temperature] into the melting point of +200 degrees C when it casts to mold when it heats in melting point of +200 degrees C or more. Moreover, the lower limit of whenever [stoving temperature] was made into the melting point of -100 degrees C because it solidified as molten metal is mold since a fluidity gets worse. In addition, it will spread round the interior of complicated mold from there being fluidity sufficient also in a temperature field with a melting point of -100 degrees C in the case of an amorphous alloy.

[0016] Moreover, although a fluidity is good, in order to make a dissolution metal spread in mold more promptly, as for an amorphous alloy, it is more desirable to pressurize and cast a molten metal side by gas in the case of cast. As pressurization gas here, inert gas, such as nitrogen, is desirable and it is desirable to pressurize in 1.5-3.0kg/cm² as the pressure.

[0017] In addition, although it will not be restricted especially about the dissolution approach of the alloy before cast and will dissolve with an electric furnace, a RF fusion furnace, etc., in order to prevent oxidation of an alloy in this case, it is desirable to make it dissolve in inert gas ambient atmospheres, such as an argon.

[0018] Although there is finally no limitation about the class of amorphous alloy which can be manufactured by this invention, it is required to be the alloy presentation according to claim 1 which has amorphous organization potency like. Here, although amorphous organization potency points out the property which can be made amorphous by quenching from a melting condition, quenching here does not point out the ultra high-speed cooling rate seen by rapid solidification, such as the single rolling method, and it has the intention of the cooling rate of 102 degrees C / sec extent not more than it. That is, if the alloy presentation which has amorphous organization potency is not based on a super-[these] quenching method, it does not contain the conventional alloy system which cannot be made amorphous.

[0019] Amorphous-izing is possible by casting which a Pt-Cu-P system alloy, a Pt-Pd-Cu-P system alloy, a Pd-Cu-nickel-P system alloy, a Zr-aluminum-nickel-Cu-P system alloy, etc. are mentioned, and starts this invention about these here as an amorphous alloy currently used as accessories or dental materials, for example. Moreover, about especially an ingredient with many opportunities to contact the body like accessories or dental materials, the Pt-Cu-P system alloy and Pt-Pd-Cu-P system alloy which do not contain the nickel called cause of allergy to metal are desirable. As a presentation of the amorphous alloy belonging to these sequences, about the former, there are $50 \leq \text{Pt} \leq 75\%$, $5 \leq \text{Cu} \leq 50\%$, and $15 \leq \text{P} \leq 25\%$ (all are atomic %), and there is a noble-metals radical amorphous alloy which consists of $5 \leq \text{Pt} \leq 75\%$, $0 < \text{Pd} \leq 50\%$, $5 \leq \text{Cu} \leq 50\%$, and $15 \leq \text{P} \leq 25\%$ (all are atomic %) about the latter.

[0020]

[Embodiment of the Invention] Hereafter, the suitable operation gestalt of this invention is explained with the example of a comparison.

[0021] The operation [1st] gestalt: The bell was manufactured with this operation gestalt, using

a Pt-Pd-Cu-P system alloy (Pt:30at% and Pd:30at% and Cu:20at% and P:20at%) as an amorphous alloy. In addition, when physical properties, such as the melting point, were investigated about the Pt-Pd-Cu-P system alloy of this presentation manufactured apart from this operation gestalt, this alloy was 352.3 degrees C in the melting point of 541.0 degrees C, and crystallization temperature. Manufacture of the bell in this operation gestalt was heated to 700 degrees C, after having mixed the powdered raw material and red phosphorus of each metal first so that it might become the above-mentioned presentation, and dissolving in Ar ambient atmosphere with an electric furnace. And the mold (thickness: a maximum of 3mm, a minimum of 0.5mm) manufactured with the ROSUTO wax was made to pressurize, cast and solidify the dissolution metal held at these 700 degrees C with nitrogen gas (2kg/cm²). Under the present circumstances, mold has cooled the perimeter with water so that that temperature may become 20 degrees C.

[0022] Consequently, the obtained sample was the bell of the good quality which reappears faithfully to the details of mold and does not have defects, such as a crack. And when differential calorimetric analysis analyzed this sample, having gazed at the both sides of glass transition temperature and crystallization temperature, and having made it amorphous was checked.

Furthermore, also by analysis by the X diffraction, a diffraction pattern is broadcloth and having made it amorphous also here was checked. Drawing 1 shows the DSC curve of the amorphous alloy manufactured with this operation gestalt. Moreover, drawing 2 shows the X diffraction pattern of the amorphous alloy manufactured with this operation gestalt. In addition, when the degree of hardness of this bell was measured, they were 500Hv(s) in Vickers hardness number.

[0023] The example 1 of a comparison: About the alloy of the same presentation as the 1st operation gestalt, mold temperature was changed and the bell was manufactured. Mold temperature here is made into 500 degrees C which is the crystallization ***** Li elevated temperature of this alloy. In addition, conditions, such as other dissolution metal temperature at the time of cast, are the same as the 1st operation gestalt.

[0024] It was the bell of the good quality in which it reappears faithfully to the details of mold and the sample obtained in this example of a comparison does not have a defect, either.

However, two or more peaks which neither glass transition temperature nor crystallization temperature is observed even if differential calorimetric analysis analyzes this sample, and show crystallization to a diffraction pattern also by analysis by the X diffraction were seen. Therefore,

the sample (bell) manufactured in this example of a comparison was checked with what is being crystallized. In addition, when the degree of hardness of this bell was measured, they were 600Hv(s) in Vickers hardness number.

[0025] The operation [2nd] gestalt: With this operation gestalt, the ring was manufactured using the Pt-Pd-Cu-P system alloy (Pt:50at% and Pd:10at% and Cu:20at% and P:20at%) with which the 1st operation gestalt differs from a presentation as an amorphous alloy. In addition, when physical properties, such as the melting point, were investigated about the Pt-Pd-Cu-P system alloy of this presentation, this alloy was 307.2 degrees C in the melting point of 501.9 degrees C, and crystallization temperature. With this operation gestalt, after having mixed each metal like the 1st operation gestalt so that it might become the above-mentioned presentation, and dissolving in Ar ambient atmosphere with an electric furnace, it heated to 600 degrees C. And the mold (the bore of 17mm, thickness of 1.5mm, width of face of 3mm) manufactured with the ROSUTO wax was made to pressurize, cast and solidify the dissolution metal held at these 600 degrees C with nitrogen gas (2kg/cm²). Under the present circumstances, mold has cooled the perimeter with water so that that temperature may become 20 degrees C.

[0026] Consequently, the obtained sample was the ring of good quality without defects, such as a crack, while reproducing the mold configuration. And when differential calorimetric analysis and X-ray diffraction analysis analyzed this sample, amorphous-ization was checked like the 1st operation gestalt.

[0027] The example 2 of a comparison: About the alloy of the same presentation as the 2nd operation gestalt, mold temperature was changed and the ring was manufactured. Mold temperature here is made into 400 degrees C which is the crystallization ***** Li elevated temperature of this alloy. In addition, conditions, such as other dissolution metal temperature at the time of cast, are the same as the 2nd operation gestalt.

[0028] It was the bell of the good quality in which it reappears faithfully to the details of mold and the sample obtained in this example of a comparison does not have a defect, either. However, amorphous-ization was not checked for this sample by differential calorimetric analysis and X-ray diffraction analysis, either.

[0029]

[Effect of the Invention] As explained above, also when casting the dissolution metal of the presentation which has amorphous organization potency according to this invention, the

solidification structure can be completely made amorphous. And especially this invention is effective to casting of the product of a complicated configuration. According to this invention, it consists of an amorphous alloy and the accessories and dental materials which have a complicated configuration can be manufactured in large quantities cheaply.

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